Searching for Irving Fisher

Kris James Mitchener
Department of Economics
Santa Clara University and NBER

Marc D. Weidenmier
Department of Economics
Claremont McKenna College and NBER

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There is a long-standing debate about the whether there was a Fisher effect during the classical gold standard period. We break new ground on this question by examining the interest-rate differential between Austrian paper and gold perpetuity bonds to impute a market-based measure of general inflation expectations during the gold standard. Our empirical investigation of inflation expectations during the gold standard period suggests several conclusions: (1) inflation expectations exhibited significant persistence at the weekly, monthly, and annual frequencies; (2) market participants forecasted a significant portion of both the gold deflation and inflation episodes during the classical gold standard period; and (3) inflation expectations are highly correlated with the nominal interest rates. Using our unique measures of inflation expectations, we find evidence in favor of the operation of the Fisher effect during the classical gold standard period.

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Mitchener: Department of Economics, Santa Clara University, 500 El Camino Real Santa Clara, CA 95050;kmitchener@scu.edu; 408.246.9543. Weidenmier: Department of Economics, Claremont McKenna College, Claremont, CA 91711; marc_weidenmier@cmc.edu; 909.607.8497.

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Several studies have found that *ex post* inflation rates are not correlated with the level of nominal interest rates during the classical gold standard period even though the Fisher equation is an empirical relationship based on inflation expectations.[1] One possible explanation for the failure of the Fisher equation in this earlier period is that inflation expectations were nearly zero given the low level of persistence in annual measures of *ex post* inflation rates (Barsky, 1987; Bordo and Kydland, 1995; Fisher, 1930; Friedman and Schwartz, 1982).[2] Other possible explanations for the lack of correlation between nominal interest rates and inflation rates include the hypotheses that financial markets had money illusion or that investors did not understand the quantity theory of money (Summers, 1983; Cagan, 1984; Choudry, 1996; Barsky and Delong, 1991).

Several scholars have attempted to estimate price and inflation expectations during the gold standard period to test for the presence of a Fisher effect using time series econometric models (Capie, Mills, and Wood, 1991). An obvious limitation to this approach is that we do not have a very good idea of the economic model that market participants used to form inflation expectations (Barsky and DeLong, 1988). Alternatively, some more recent studies have used data on agricultural futures to derive a measure of inflation expectations (Siegler and Perez, 2003). But, as the authors importantly point out, trading in futures markets was quite thin during the gold standard

[1] Many studies have found that nominal interest rates during the gold standard are correlated with the price level rather than the rate of inflation. Barsky and Summers (1983) argue that that the positive correlation of nominal interest rates with the price level is a direct result of the fact that the price level in the inverse of the price of gold. Benjamin and Kochin (1984) argue that Gibson’s Paradox was spurious.

[2] For a discussion of inflation expectations during the gold standard period, see Barsky and DeLong (1983). For an analysis of the persistence of inflation during the gold standard period and later, see Burdekin and Siklos (1996). Harley (1977) analyzes prices and interest rates in the UK during the gold standard period to test Gibson’s Paradox.

and estimation sometimes requires interpolation techniques to construct a continuous times series. In addition, agricultural futures only cover individual commodities, and hence are based on the assumption that agricultural prices track overall inflation. This approach suffers from a failure to distinguish between changes in relative prices versus changes in the overall price level (Bordo and Schwartz, 1981). Summarizing the literature, McCallum (1984) points out that studies of pre-World War I changes in the price level have simply shown that past inflation cannot forecast future inflation. But these results say very little about inflation expectations or the failure of the Fisher effect during the gold standard period.

To improve upon the existing literature, we have collected a unique data set based on high-frequency, asset price data that allows us to compute a market-based measure of inflation expectations for the 19th century. In particular, we use data on Austrian paper, gold, and silver government bonds to compute measures of inflation expectations at high and low frequencies during the classical gold standard period to test for the presence of a short and long-run Fisher effect. Austria was the only major European country during the classical gold standard period that issued gold, paper, and silver perpetuity bonds that actively traded on the leading financial exchanges of Europe including London, Paris, Berlin, Amsterdam and Vienna.

We use the interest-rate differential between Austrian paper and gold bonds to derive an *ex ante* market-based measure of inflation expectations. We suggest that gold bonds were essentially inflation-indexed securities, much like modern-day TIPS, whereas paper bonds required an inflation premium to make the debt obligations attractive to investors in international capital markets. Our empirical analysis suggests that inflation expectations were not a white noise process during the gold standard period. We find economically meaningful persistence in inflation expectations at the weekly, monthly, and annual frequencies that can be used to forecast realized inflation. As predicted by the Fisher equation, we also find that expected inflation was positively related to the level of nominal interest rates. Inflation expectations for Austria also Granger-cause changes in the gold-silver price ratio. Using our unique measures of inflation expectations, we find evidence in favor of the operation of the Fisher effect during the classical gold standard period.

We begin with a discussion of our data on Austrian bonds during the classical gold standard period. We then analyze the time series properties of inflation expectations during our sample period in Austria. We then test the short and long-run Fisher effect using interest rate data from Austria and other countries during the gold standard. The last section discusses our findings and their implications for the literature on the Fisher effect.

II. Austria and the Gold Standard

Some scholars have characterized nineteenth-century Austria as a financially underdeveloped, agriculturally-oriented economy, suggesting that it belonged to the periphery rather than to the core of European gold standard countries like the United Kingdom, France, or Germany. Although its GDP per capita was lower than the UK, Austria's standard of living compares favorably with France and Germany prior to the outbreak of World War I (see Figure 1). Austria was also one of the leading European military powers of the late nineteenth century and its financial markets appear to have been well developed and integrated (Good, 1977). After 1816, it had a central bank, modeled after the Bank of France, which had sole right of note issue and a network of joint stock banks with extensive branching networks (including the important Viennese banks) that lent to businesses throughout the Austrian empire. It also borrowed from the German model of universal banking in forming institutions such as the Creditanstalt fur Handel und Gewerbe (1855).

As for exchange rate policy, Austria was a member of the silver standard for much of the nineteenth century. The Compromise of 1867 between Austria and Hungary gave constitutional foundations for a monetary union with the silver florin as the monetary standard. After 1879, the florin was no longer convertible into silver and the exchange-rate system often resembled a float more than a peg. Silver florin traded for as much as seven percent away from the mint par ratio and, as shown in Figure 2, weekly exchange rates exhibited significant fluctuations in the 1880s. In August 1892, Austria joined the gold standard and established a new currency, the crown (kronen). Flandreau and Komlos (2001) argue that even though Austria never formally established gold convertibility prior to World War I, the country was a *de facto* member of the gold standard because of the stability of its exchange rate. The Austrian crown exchange rate fluctuated only +/- 0.4 percent from mint par after 1896. Figure 2 confirms that Austrian exchange rates were remarkably stable after the country joined the gold standard. Based on the behavior of the exchange rate, Flandreau and Komlos (2001) conclude that Austria was a country that was neither a core nor peripheral member of the gold standard, but rather somewhere in between.

However, additional historical evidence from bond markets suggests that Austria may have more closely resembled a core gold standard country. In contrast to periphery countries, it successfully floated large amounts of government debt throughout Europe in its own currency. It did not suffer from so-called "original sin" (Eichengreen and Hausmann, 1999; Bordo, Meissner, and Redish, 2005). Only the UK, France, Germany, Netherlands, and the United States were also able to sell large bond issues in their home currency on several European markets during the classical gold standard period. Austria tapped international capital markets on a significant scale following the passage of the Law of March 16, 1876. The legislation authorized a 16 million florin bond issue that was exempt from Austrian taxes and paid interest half-year in gold in Vienna and other European exchanges including Amsterdam, Berlin, Brussels, Frankfurt, and Paris. Morys (2008) estimated that foreigners held approximately 20 percent of the debt issue.

Austria also issued paper and silver bonds on the leading European exchanges. Like the gold bonds, the two debt issues did not contain a sinking-fund and had a five-percent coupon. The bonds were perpetuity obligations and subject to a 16 percent income tax. The coupon payments on the paper bonds were payable half-yearly on February or August 1st or on May 1st and November 1st (*Stock Exchange Official Intelligence*, various issues). The market value of unredeemed paper bonds exceeded 443fl million in 1901. The silver debt, issued in 1868, also had hundreds of million fl outstanding. We have assembled weekly prices of the paper, gold, and silver sovereign debt issues of Austria over the period 1880-1903.[3] We employ these bond series to derive a market-based measure of inflation expectations and to test for the presence of a Fisher effect during the gold standard period.

[3] We are presently working on extending the data to cover the entire classical gold standard period.

III. Empirical Analysis

A. Model

The Fisher equation states that the nominal interest rates on a given sovereign debt obligation is equal to the real interest rate plus the expected rate of inflation. The nominal interest rate for Austrian paper bonds can be written as:

(1) $i_t^P = r_t + \pi_t^{e,P}$

where r_t is the real interest rate and $\pi_t^{e,P}$ is the expected rate of inflation. The Fisher equation for Austrian gold bonds can be written as

(2) $i_t^G = r_t + \pi_t^{e,G}$

However, unlike the paper bond, since this debt obligation is payable in gold, inflation expectations, denoted by $\pi_t^{e,G}$, are assumed to be zero. The paper-gold interest-rate differential can be obtained by subtracting equation (2) from equation (1).

(3) $i_t^{P-G} = \pi_t^e$

Equation (3) states that the paper-gold interest rate spread is equal to the expected rate of inflation.

To carry out the empirical analysis below, we make three assumptions about the bonds and investor behavior: (1) investors are risk-neutral; (2) the real interest rate is the same for both bonds given that the Austrian government issued the two debt obligations; and (3) paper and gold bonds have identical default risk. The third assumption of identical default risk appears reasonable given that Austria faithfully repaid its sovereign debt during the entire gold standard period. Even if there were some differential default risk between paper and gold bonds, the premium is not likely large enough to have a qualitative impact our analysis.

The imputed measure of inflation expectations, π^e_t, along with Austrian paper-bond interest rates are presented in Figure 3. The simple correlation coefficient between this nominal interest rate and inflation expectations is more than 90 percent. Inflation expectations over the entire sample period averaged 1.38 percent (138) basis points and accounted for approximately 20 percent of the nominal interest rate (inflation expectations/nominal interest rate). Since inflation expectations were relatively stable (the standard deviation is less than three percent), the empirical evidence also indicates, as suggested by Siegel and Shiller (1977), that movements in real interest rates were probably more important than inflation expectations in driving fluctuations in Austrian nominal interest rates.

B. Persistence in Inflation Expectations

To examine the time-series properties of inflation expectations during the classical gold standard period, we first test for a unit root using the Augmented-Dicker Fuller test. The null hypothesis of a unit root could not be rejected at the five- or ten-percent level of significance.[4] Figure 3, however, suggests that the adoption of the gold standard may have led to a structural break in the formation of inflation expectations as the country implemented monetary and fiscal reforms in the late 1880s, and which in turn reduced the level of nominal interest rates.

[4] The test statistic for the ADF test was -0.80.

To test formally for a structural break, we employ the methodology developed by Zivot-Andrews (1992). This test allows us to examine whether adopting the gold standard lowered the level, trend, or level and trend of inflation expectations. The Zivot-Andrews procedure does not specify a breakpoint, *a priori*, given that the pre-selection of a change point biases the results towards finding a structural break (Christiano, 1992). The null hypothesis of the structural break model, H_0, is that inflation expectations are a nonstationary process:

(4) $$\pi_t^e = \mu + \pi_t^e + e_t$$

where μ is the mean of a given time series and e_t is a white noise disturbance term. Three different alternative hypotheses, $H_1^{2,3,4}$, can be written as follows:

(5) $$\Delta y_t = \mu + \beta t + \theta DU_t + \alpha y_{t-1} + \sum_{j=1}^{k} c_j \Delta y_{t-j} + e_t$$

(6) $$\Delta y_t = \mu + \beta t + \gamma DT_t + \alpha y_{t-1} + \sum_{j=1}^{k} c_j \Delta y_{t-j} + e_t$$

7) $$\Delta y_t = \mu + \beta t + \theta DU_t + \gamma DT_t + \alpha y_{t-1} + \sum_{j=1}^{k} c_j \Delta y_{t-j} + e_t$$

Equation (5) is a "crash" model that allows for a one-time change in the level of inflation expectations at a break date denoted by TB. This specification captures the large drop in inflation expectations in the late 1880s early 1890s. Equation (6) is used to test for stationarity around a broken trend at TB. This specification allows for a gradual decline in inflation expectations if the "good housekeeping" effect of the gold standard is incorporated into interest rates over a long period of time. Equation (7) is the most general specification that allows for a change in the intercept and trend of inflation expectations at TB.

DU_t is a dummy variable that captures the shift in the intercept and takes a value of 1 if t>TB. DT_t is another indicator variable that represents the shift in the deterministic trend at time TB. DT_t is equal to (t-TB) if (t>TB) and zero otherwise. To control for serial correlation, we also included lagged differences of the dependent variable as covariates in the three models. The number of lagged differences employed in the break tests is selected on the basis of the Akaike Information Criteria (AIC). In each of the three alternative hypotheses, π_t^e is assumed to be a stationary process with one structural break. The null hypothesis is rejected if the α_t coefficient is significantly different from zero. The empirical results for the structural break test are presented in Table 1. The analysis suggests that the adoption of the gold standard led to a structural change in both the trend and level of inflation expectations at the one-percent level of significance for Austria on August 4, 1888; however, we are unable to reject the null hypothesis of a structural break for the crash and trend break models.

Based on the results of the structural break analysis, we then estimate ARIMA models for the periods when Austria was a member of the silver and gold standards to measure the persistence of inflation expectations. Austria was a member of the silver standard from the 1848 Revolution until July 1892 and a member of the gold club from August 1892 until the outbreak of World War I.

In order to avoid contaminating the empirical results with the large drop in inflation expectations that accompanied the economic reforms, we estimate ARIMA models for the silver standard over the sample period January 1880 to August 1888 – the period before the structural break. In the late 1880s and early 1890s, Austria, reduced its budget deficit, acquired gold, and retired outstanding government paper notes as it prepared to adopt the gold standard (Flandreau and Komlos, 2001). As shown in Table 2, inflation expectations in Austria are best characterized by an AR(2) process when it was a member of the silver standard. The sum of the autoregressive coefficients, which has the value of .92, indicates a very high level of persistence in inflation expectations. The coefficient on the constant term in the equation suggests that financial market participants expected inflation to average approximately 1.76 percent per year.

For the gold standard period, we estimate ARIMA models from August 1892 to April 1903, and find that the best model for inflation expectations is an AR(1) model. Table 2 shows that the level of inflation persistence drops from about 95 percent to about 92 percent. Although we observe a similar level of persistence in inflation expectations after Austria joined the gold standard, there is a marked reduction in the average level of inflation expectations from 1.73 percent to 1.14 percent. These findings suggest that there was significant persistence in inflation expectations and that joining the gold reduced the average level of inflation expectations by roughly 40 percent.

One potential problem with the empirical results is that the persistence of inflation expectations is simply a result of using high frequency data imputed from weekly interest rates. To consider this possibility, we re-estimated the baseline empirical results using end-of-month data. The ARIMA models of monthly inflation expectations are presented in Table 3. The results are similar to those employing the weekly data. Inflation expectations followed an AR(2) process when the country adhered to the silver standard and inflation persistence is still nearly 90 percent and significant at the one-percent level. For the gold standard period, inflation expectations are still best modeled as an AR(1) process. Although inflation expectations are once again not a white noise process, the coefficient on the autoregressive term falls by about 30 percent, from 92 to almost 70 percent.

We find similar results using annual data even though the sample period is quite short and the unit root test for the annual data on inflation persistence is only marginally statistically significant.[5] Table 4 shows that inflation expectations averaged more than 1.3 percent over the period 1880-1903. Again, we find that there is significant persistence with the sum of the two autoregressive terms greater than 0.80. Hence, using weekly, monthly, or annual data, we find substantial persistence in inflation expectations during the gold standard period.

One possible critique of our analysis is that Austria’s commitment to gold might have been perceived as less credible, and hence the analysis of inflation expectations we derive for it may not be very representative of gold club members. That is, inflation expectations for non-credible members of the gold standard may be much larger than for countries that strictly adhered to the monetary rule. While Austria was a newer member of the gold standard in comparison to France, Germany, and the UK, it does not appear that market participants viewed its commitment to gold as substantially less credible than these countries. Mitchener and Weidenmier (2008) provide evidence that Austria was one

[5] The null hypothesis of a unit root can only be rejected at the 15 percent level of significance. We hope to extend the database to 1913 in future drafts of the manuscript.

of the most credible gold standard monetary regimes during the period 1870-1913: market participants expected Austrian kroner to depreciate approximately three percent after the country joined the gold standard. The level of expected depreciation is considerably smaller than several other gold standard countries including the United States, Argentina, Brazil, Chile, India, Mexico, and Russia. We therefore interpret our results as providing a lower bound on the size and persistence of inflation expectations for the average country during the classical gold standard period.

C. Forecastibility of Inflation

The presence of significant persistence in inflation expectations suggests that the interest-rate differential between paper and gold bonds might be able to predict future inflation rates during the gold standard. One problem with testing this hypothesis during the gold standard is that price indices from this period do not always provide useful information. Governments did not regularly collect information on the goods and services people purchased on a monthly basis (Perez and Siegler, 2003; Hanes, 1999).[6] This makes it difficult to construct reliable consumer price indices that can be compared to a general measure of inflation expectations imputed from financial markets. A possible solution for dealing with the problem of incomplete price figures is to examine the interest-rate differential between Austrian gold and silver bonds. This yield spread should reflect inflation expectations regarding the gold-silver price ratio, a relative price that was widely followed by investors and reported on by the major financial newspapers during

[6] Hanes (1999) constructed a consistent consumer price index series for the United States from 1870-1990. For the gold standard period, he constructs a consumer price index based on 1911 survey from the United States Bureau of the Census.

the gold standard. The monthly gold-silver price ratio, shown in Figure 4, sharply declines in the first part of the sample period and then fluctuates up and down from about 1894 until the outbreak of World War I. The gold-silver interest-rate differential, our measure of inflation expectations, also appears in Figure 4. The correlation coefficient between the two price series is approximately 60 percent.

To test whether gold-silver inflation expectations can forecast actual movements in the relative price, we first tested the gold-silver price ratio for a unit root. The null hypothesis of a unit root could easily be rejected at the one percent level of significance.[7] We then ran a series of Granger-causality tests to test if inflation expectations imputed from the silver-gold interest rate differential can predict movements in changes in the gold-silver price ratio. We estimated VARs with lags lengths of one to six for the periods when Austria was a member of the gold and silver standard. The results for the silver standard period suggest that inflation expectations do not Granger-cause changes in the gold-silver price ratio (Table 5). However, we do find some evidence that changes in the gold-silver price ratio Granger-causes inflation expectations. We hope to provide more perspective on the relationship between the timing of fluctuations in inflation expectations and changes in the gold-silver price ratio with higher frequency, weekly data. For the gold standard period, we find that the interest-rate differential between Austrian silver and gold bonds Granger-causes changes in the gold-silver price ratio for lag lengths of one to three. In all six VARs, the coefficient on the first lag of the interest-rate spread in the change in the gold-silver price ratio regression is two percent and statistically significant at the one percent level. This suggests that financial market

[7] The test statistics for Augmented Dicker-Fuller test was nearly -15 with a p-value of .00000.

participants used inflation expectations to help forecast movements in the gold-silver price ratio.

D. Fisher Effect

1. *Short-Run Tests*

To test for the presence of a short-run Fisher Effect, we analyze the relationship between the Vienna Open market interest rate and our measure of inflation expectations.[8] The Vienna open market rate is the most important short-term money market rate used to conduct trade with other countries. The Austrian short-term rate along with the paper-gold interest rate spread is shown in Figure 5. Unlike inflation expectations, there is no visual evidence of a structural break in the short-term interest rate series. The lack of a structural break may be explained by the fact that the Vienna open market security was denominated in gold. Hence joining the gold standard would have little impact on the money market interest rate.

To analyze the relationship between short-term interest rates and inflation expectations in more detail, we estimate a series of Granger-causality tests. We first test the short-term interest rate series for a unit root using the Augmented Dickey-Fuller test. We can easily reject the null hypothesis of no unit root at the one-percent level of significance.[9] As shown in Figure 5, the short-term open market appears to be mean reverting for Austria. Given that we identified a structural break in the time series of inflation expectations, we estimate Granger-causality tests for the sample periods when

[8] For studies examining the Fisher effect using modern data, see Mishkin (1981, 1992) and Fama (1975).
[9] The fact that the null hypothesis of a unit root can easily be rejected for the short-term interest rate series shows that there is not a structural break in the time series.

Austria was a member of the silver (January 1880-July 1888) and gold standards (August 1892-April 1903). We estimate Granger-Causality tests with lag lengths from one to six for the two sample periods. The results appear in Tables 6. In all six VARs for the two periods, we are unable to reject the null hypothesis that inflation expectations Granger-cause short-term interest rates at the five or ten percent level of significance.

One possible explanation for the lack of Granger-causality is that the Austrian sovereign debt and money markets are very efficient and clear quite quickly. If this were true, we should not expect lagged values of inflation expectations to predict short-term interest rates. To consider this possibility, we calculate the forecast error variance of short-term interest rates and inflation expectations using a standard Choleski decomposition to determine the extent to which fluctuations in inflation expectations drove short-term interest rates for Austria. We give inflation expectations the first ordering in the system so that shocks to inflation expectations have a contemporaneous effect on short-term interest rates, but short-term interest rates do not have a contemporaneous impact on inflation expectations. We estimate a VAR using six lags to construct the variance decomposition. We find that inflation expectations can account for less than four percent of the movements in short-term interest rates for each week up to a 36-week forecast horizon.

The evidence suggests that there is a weak link between inflation expectations and short-term interest rates for Austria. We believe that this simply reflects the fact that short-term interest rates during the gold standard were often denominated in hard currency. As a result, market participants considered short-term interest rates to be inflation-indexed securities.

2. Long-Run Fisher Effect

We test for the presence of a long-run Fisher effect using Austrian silver bonds. The nominal interest rate should provide some insight into whether there was a relationship between nominal interest rates and expected inflation. Since silver became largely demonetized in the early 1890s, the precious metal functioned more as commodity as opposed to a metal used as a currency.[10] Figure 6 shows Austrian inflation expectations along with the silver currency bonds for the period when the European country was on the gold standard. The two series move together over the entire sample, suggesting a strong positive link between nominal interest rates and expected inflation.

We examine the relationship between Austrian inflation expectations and the interest rate on silver bonds using Granger-causality tests. We first test the time series of silver interest rates for a unit root using the Augmented Dickey-Fuller test. The null hypothesis of a unit root cannot be rejected using either a constant or constant and trend in the model. As discussed earlier, inflation expectations calculated using the paper-gold differential are stationary regardless of whether a trend is specified in the model. Although the two time series have different orders of integration based on unit root tests, a long-run equilibrium relationship may nevertheless still exist. To test for one, we look for cointegration using the Engle-Granger test. With a test statistic of 3.6, we can reject the null hypothesis of no cointegration at the five-percent level. We interpret the results as strong evidence of the presence of a Fisher effect – a long-run relationship between

[10] A few countries and colonies continued to use silver throughout the gold standard period including China and Hong Kong.

inflation expectations and nominal interest rates. In the future, we would like to expand our analysis of the Fisher effect to include paper currency bonds issued by leading firms on the Vienna Bourse. An analysis of corporate paper bonds would provide additional information on the link between nominal interest rates and inflation expectations during the classical gold standard period.

V. Conclusions

Economists have now entered a second century of searching for Irving Fisher. We believe we have found him, lurking in the inflation expectations of the classical gold standard period. We discovered the presence of the Fisher effect by providing one of the first, high-frequency market-based measures of general inflation expectations for the classical gold standard period so that we could actually test for the presence of such an effect. Previous studies have used gold bonds and econometric models to examine the relationship between nominal interest rates and inflation. We believe that our measure, the interest rate differential between gold and paper bonds, provides a more direct approach for studying the behavior of inflation expectations during the gold standard period and its relation to actual inflation.

Our analysis of inflation expectations suggests several conclusions. First, the adoption of the gold standard led to a structural change in the average level of inflation expectations in Austria. Joining the gold standard led to a 40 percent drop in inflation expectations, from 1.7 percent to 1.2 percent, as measured by decisions made in financial markets. We also find that there is considerable persistence in inflation expectations at the weekly, monthly, and annual frequencies. Market participants clearly forecast a significant portion of gold deflation and gold inflation as well as the switch from a declining price level to an increasing price level in the mid-1890s as shown by our analysis of the gold-silver price ratio. Finally, we find evidence of a long-run Fisher effect: silver interest rates have a long-run equilibrium relationship with inflation expectations that were derived using the paper-gold interest-rate differential. Market participants during the classical gold standard period required an inflation premium that was built into nominal interest rates as long as the debt obligation was denominated in paper rather than gold.

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Table 1. Zivot-Andrews Structural Break Tests, 1880-1903

Break Test	Minimum T-Test	Break Date
Intercept	-3.557	1888/8/4
Trend	-1.791	1884/7/5
Intercept and Trend	-5.607***	1888/8/4
Observations	1,219	

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 2. ARIMA Models of Inflation Expectations (Weekly Data)

	Silver Standard	Gold Standard
Constant	176.00*** (10.864)	114.273*** (2.280)
AR(1)	0.759*** (0.046)	0.930*** (0.016)
AR(2)	0.209*** (0.047)	
Observations	447	562

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3. ARIMA Models of Inflation Expectations (Monthly Data)

	Silver Standard	Gold Standard
Constant	182.721*** (20.075)	114.224*** (2.311)
AR(1)	0.659*** (0.098)	0.729*** (0.061)
AR(2)	0.281*** (0.100)	
Observations	101	129

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4. ARIMA Models of Inflation Expectations (Annual Data)

	Whole Period
Constant	134.654*** (17.532)
AR(1)	1.226*** (0.207)
AR(2)	-0.443**

	(0.209)
Observations	22

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5
Forecasting the Gold-Silver Price Ratio
Granger-Causality Tests (F-tests)

Lags	Silver Standard	Gold Standard
1	1.164	4.809***
2	0.714	3.235**
3	1.294	2.276*
4	1.002	1.752
5	1.479	1.563
6	1.156	1.244

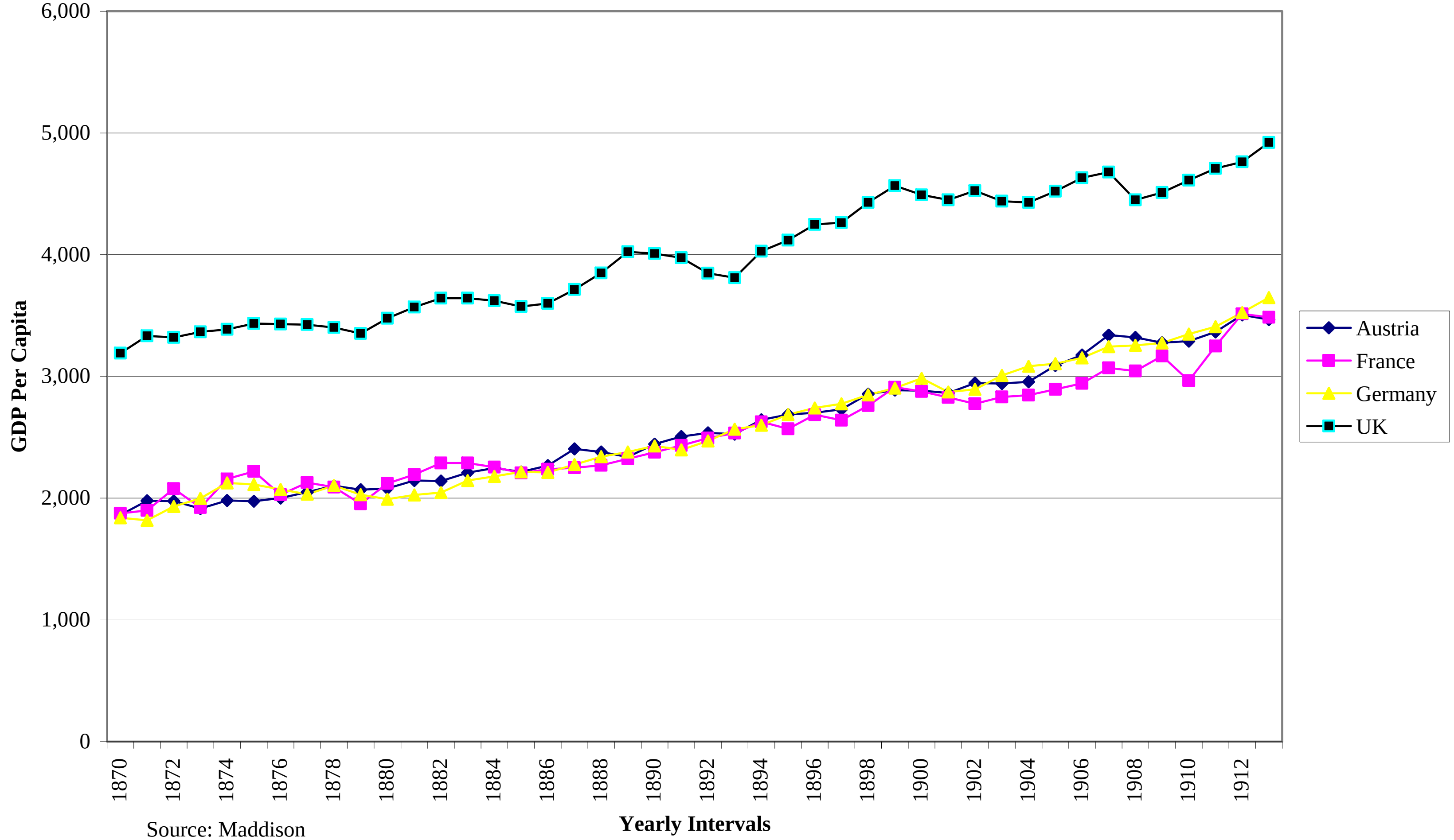
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6
Short-Term Fisher Effect
Granger-Causality Tests (F-tests)

Lags	Silver Standard	Gold Standard
1	1.446	0.038
2	1.314	1.492
3	0.0849	1.085
4	1.222	0.882
5	1.015	0.818
6	1.400	0.777

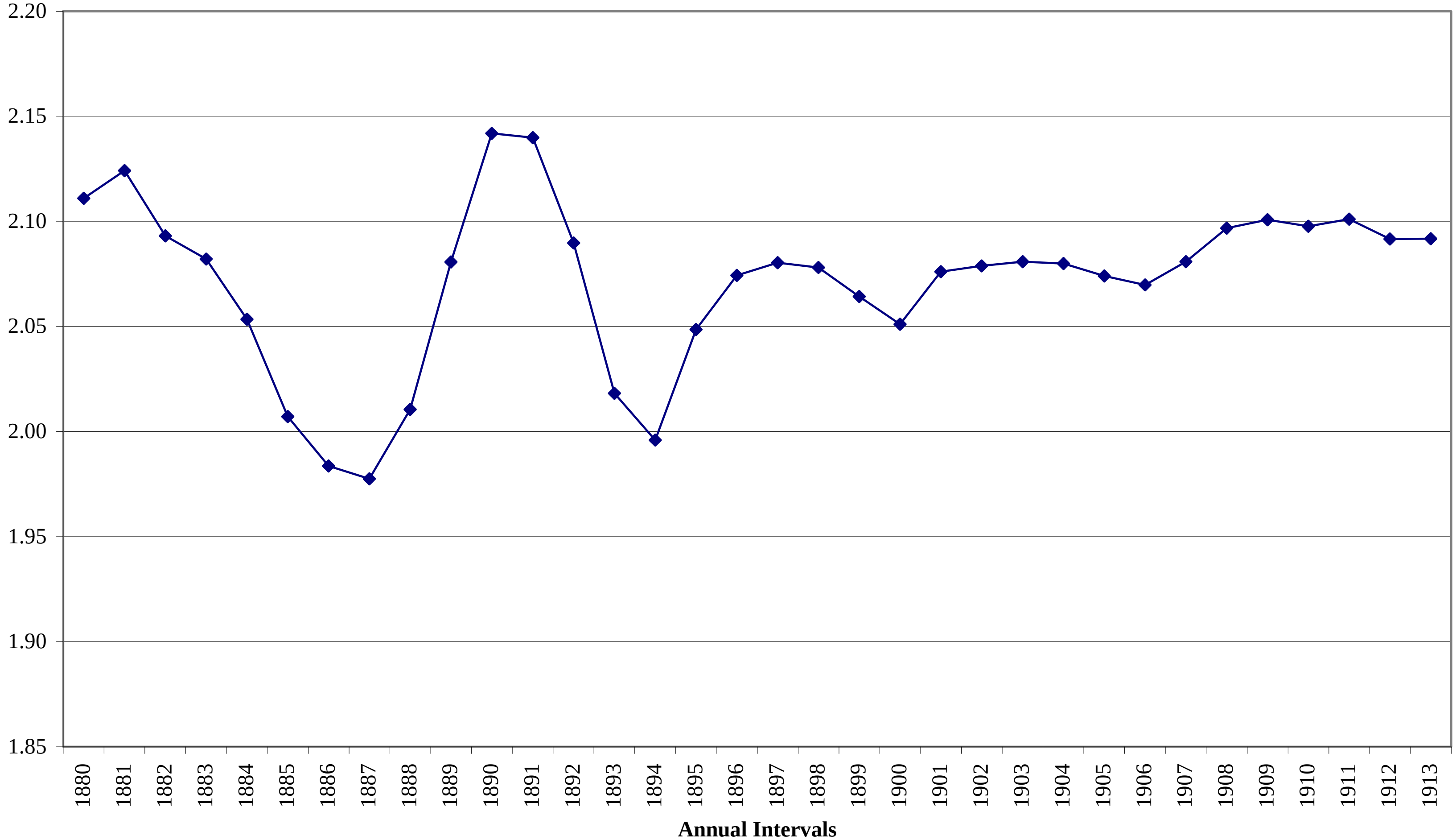
*significant at 10%; ** significant at 5%; *** significant at 1%

Figure 1
GDP Per Capita, 1870-1913



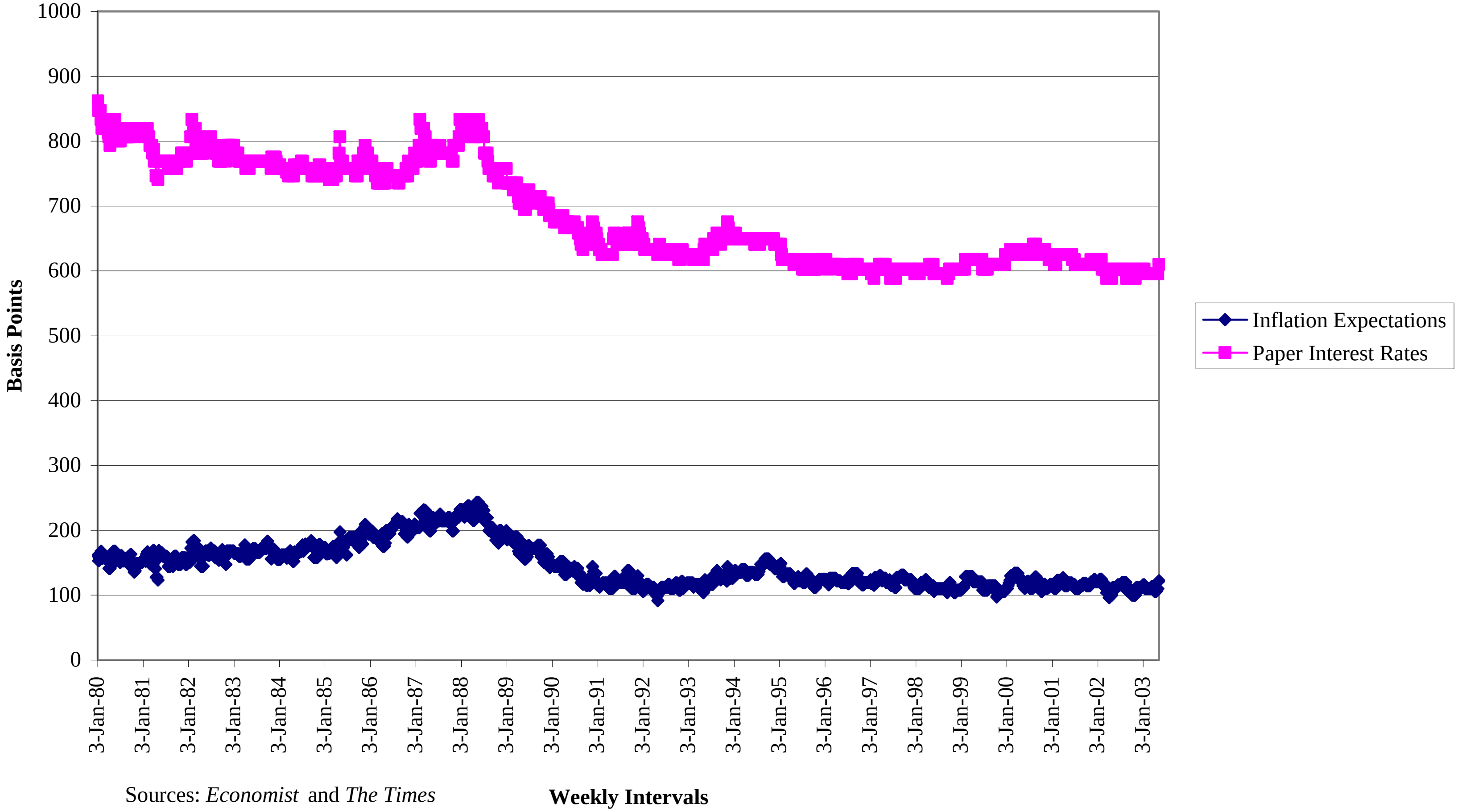
Source: Maddison

Figure 2
Franco-Austrian Exchange Rate 1880-1913



Source: Flandreau and Zumer (2004)

Figure 3
Austrian Inflation Expectations and Nominal (Paper) Interest Rates, Jan. 1880-April 1903



Sources: *Economist* and *The Times*

Figure 4
Silver Inflation Expectations and Gold-Silver Price Inflation, 1880-April 1903

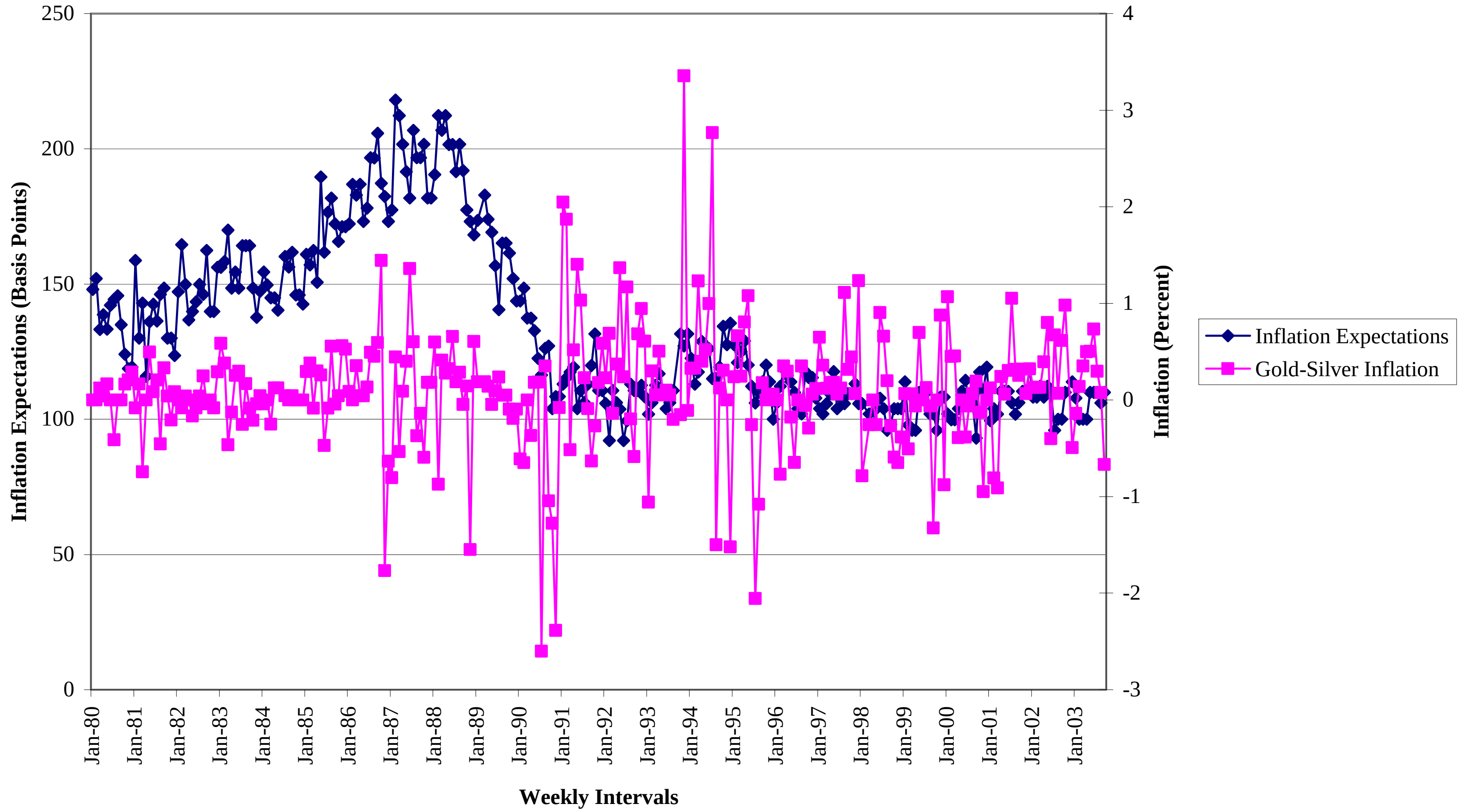


Figure 5
Short-Term Interest Rates and Inflation Expectations, 1880-April 1903

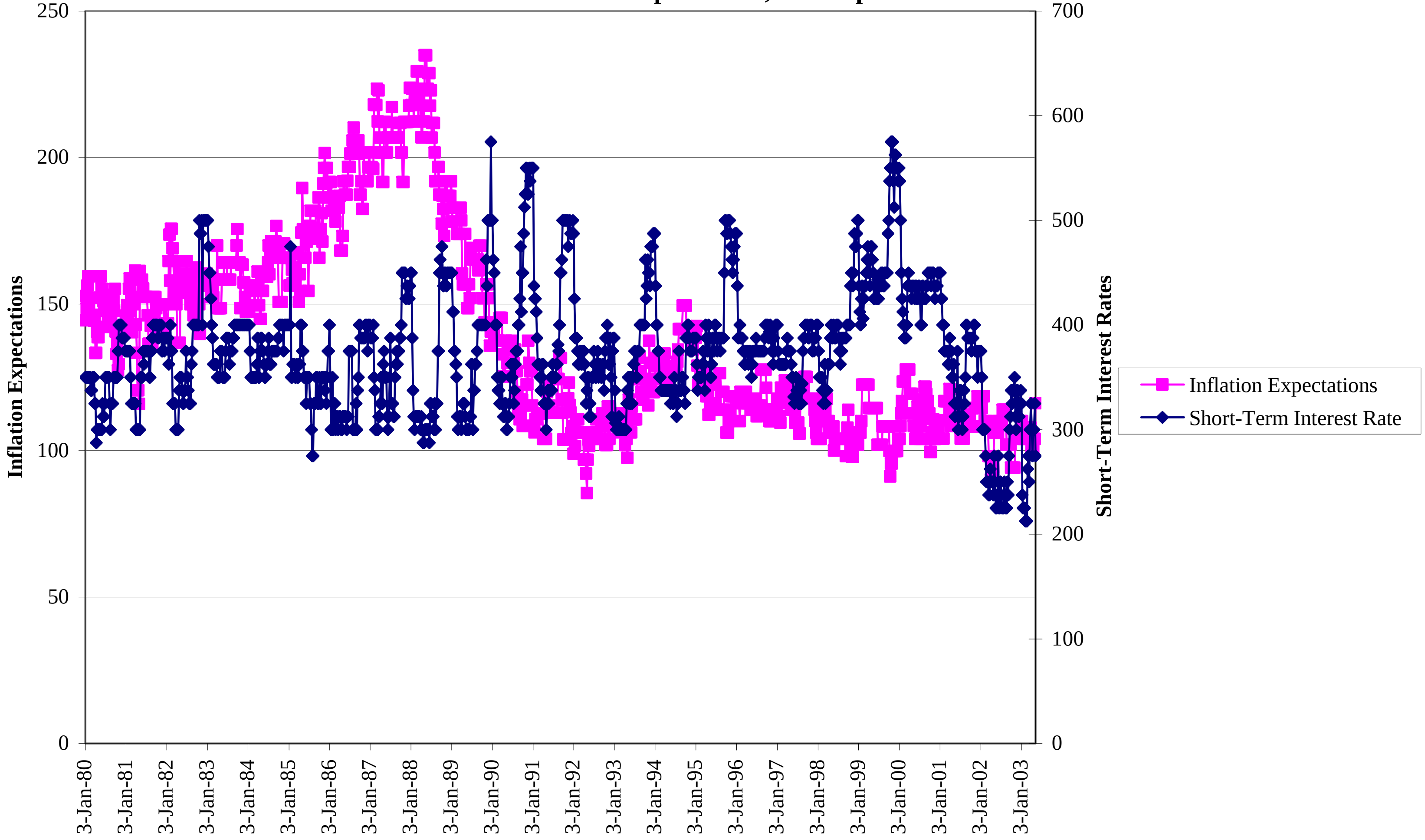


Figure 6
Inflation Expectations and Silver Interest Rates, August 1892-April 1903